20. The apparatus of claim 11 wherein said first beam of light illumiantes the first stripe shaped region at a first angle of incidence that is angularly adjustable and said second beam of light illuminates the second stripe shaped region at a second angle of incidence that is angularly adjustable.

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21. The apparatus of claim 20 wherein the approach angle and angle of incidence of the first beam of light are each angularly adjustable independent of the approach angle and angle of incidence, respectively, of the second beam of light.

REMARKS

The comments by the Examiner in the above noted Office Action have been diligently studied. Reconsideration of the application in light of this amendment is respectfully requested.

Claims 1-3, 4, 5, 11, 15, 18 and 19 have been amended. No claims have been canceled. Claims 20 and 21 have been added. Therefore, claims 1-21 are under active consideration.

Claims 1-3, 4, 5, 11, 15, 18 and 19 have been amended to overcome the objections noted in paragraphs 3-5 of the Office Action. Withdrawal of the objection to these claims is respectfully urged.

Claims 11-17 and 19 stand rejected under 35 USC 103(a) as being unpatentable over Nakata in view of Bishop. This rejection is respectfully traversed.

Applicant has invented a method and apparatus for inspecting a surface of a semiconductor wafer having repetitive patterns for contaminant particles using scattered light which involves directing two beams of light. The first beam of light illuminates the wafer at a first approach angle and the second beam of light illuminates

the wafer at a second approach angle. The two approach angles are angularly adjustable, and angularly adjustable independent of each other onto the surface in a manner so as to illuminate two intersecting stripe shaped regions on the surface. An imaging lens collects scattered light from the surface as the semiconductor wafer is moving and then images the scattered light collected onto a CCD camera having a square array sensor and arranged to operate in a time delayed integration (TDI) mode. The field of view of the CCD camera is centered at the intersection of the two striped regions. Each light beam striking the surface produces a Fourier diffraction pattern of scattered light in the back focal plane of the imaging lens. In setting up the apparatus, the angle of incidence of one of the light beams is adjusted to shift one of the diffraction patterns, if necessary, so that it overlaps the other diffraction pattern. If the two approach angles are symmetrically disposed, then the two diffraction patterns overlap and adjustment of the angle of incidence of one of the beams is not necessary.

Nakata et al discloses a method and apparatus for detecting foreign matter on a sample by illuminating a stripe-shaped region with linearly polarized light. Some of the light reflected by the sample is intercepted by a light intercepting stage, and the rest of the light reflected by the sample, which passes through the light intercepting stage is directed to a detecting optical system, to be detected by a photodetector. The sample is illuminated obliquely at a predetermined angle with respect to a group of straight lines constituting a primary pattern on the sample. The angle is selected so that the diffraction light reflected by the group of straight lines does not enter the detecting optical system. A polarizing spatial filter using a liquid crystal element may be disposed in a predetermined restricted region in a spacial frequency region, or Fourier

transformation plane, within the detecting optical system. The light scattered by the sample may further be separated in the detecting optical system into partial beams having different wave orientation characteristics, which characteristics are detected by a number of one dimensional solid stage imaging elements. The signals are processed by a driver, adder, and quantizer in synchronism with the one-dimensional solid stage imaging elements.

In Bishop semiconductor wafers, circuit boards and similar multilayer structures are optically inspected at high speeds with the aid of preferably a pair of oppositely and inclinedly directed laser beams at inclined angles to the vertical and the wafer surface to cause fluorescence by a photoresist layer carrying conductor patterns, defects in which are to be inspected, and using preferably a time-delay-integration CCD imaging camera for recording a fluorescent resist surface image accentuating the non-fluorescing conductor pattern thereupon, while masking all light from layers there below.

In the rejection, the Examiner appears to be relying on Fig. 10 in Bishop for its showing of a single light source for producing first and second beams of light.

The problem with Nakata combined with Bishop is that, among other things, although the system in Fig. 10 in Bishop appears to show two light beams emanating from a single light source, the two light beams in Bishop have approach angles that are fixed and not angularly adjustable, as required in all of these claims. Furthermore, the two light beams certainly do not have approach angles that are angularly adjustable independent of each other.

Accordingly, at least for the reason noted above, withdrawal of the rejection is respectfully urged.

Claim 18 stands rejected as unpatentable over Nakata et al in view of Nishi and Bishop.

This rejection is respectfully traversed.

The addition of Nishi for its showing of an x-y stage having linear motors for linear movement in the x and y directions does not overcome the basic shortcoming noted above with Bishop in that the two light beams are fixed and not angularly adjustable.

Allowance of the application with claims 1-21 is earnestly solicited.

Respectfully submitted,

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I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail, in an envelope addressed to Mail Stop Fee Amendment, Commissioner of Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on 6-3-03.

Irving M. Kriegsman

Marked Up Claims 1-3, 4, 5, 11, 15, 18 and 19

1. (Twice Amended) An apparatus for detecting the presence of contaminant particles on a surface of a semiconductor wafer having repetitive patterns, said apparatus comprising:

[a.] (a) means for producing a first beam of light and a second beam of light,

[b.] (b) first optical means for illuminating a first region area on the semiconductor wafer with said first beam of light,

[c.] (c) second optical means for illuminating a second region on the semiconductor wafer sample with said second beam of light,

[d.] (d) said first beam of light striking the semiconductor wafer at a first approach angle which is angularly adjustable and a first angle of incidence which is angularly adjustable,

[e.] (e) said second beam of light striking the semiconductor wafer at a second approach angle which is angularly adjustable and a second angle of incidence which is angularly adjustable,

[f.] (f) said first approach angle and said first angle of incidence being adjustable independent of said second approach angle and said second angle of incidence, respectively,

[g.] (g) an imaging detector disposed above the semiconductor wafer for detecting light scattered from the area illuminated but not specularly reflected light,

[h.] (h) an imaging lens for imaging said area illuminated on said imaging detector, said imaging lens having a Fourier plane, and

[i.] (i) a spatial filter in the Fourier plane of the imaging lens for masking off the diffraction pattern produced by the background on the semiconductor wafer from each one of the two illuminating beams of light.

2. (Twice Amended) An apparatus for detecting the presence of contaminant particles on a semiconductor wafer having repetitive patterns, said apparatus comprising:

[a.] (a) means for producing a first beam of light and a second beam of light,

[b.] (b) first optical means for illuminating a first region on the semiconductor wafer with said first beam of light,

[c.] (c) second optical means for illuminating a second region on the semiconductor wafer with said second beam of light,

[d.] (d) said first beam of light striking the semiconductor wafer at a first approach angle and a first angle of incidence,

[e.] (e) said second beam of light striking the semiconductor wafer at a second approach angle and a second angle of incidence,

[f.] (f) said first optical means including a variable angle mirror for varying the first angle of incidence,

[g.] (g) said second optical means including a variable angle mirror for varying the second angle of incidence,

[h.] (h) a first tower for holding said first optical means, said first tower being angularly movable so as to change said first approach angle,

[i.] (i) a second tower for holding said second optical means, said second tower being angularly movable so as to change said second approach angle,

[j.] (j) said first approach angle and said first angle of incidence being adjustable independent of said of said second approach angle and said second angle of incidence, respectively,

[k.] (k) an imaging detector disposed above the semiconductor wafer for detecting light scattered from the area illuminated but not specularly reflected light,

[l.] (l) an imaging lens for imaging said area illuminated on said imaging detector, said imaging lens having a Fourier plane, and

[m.] (m) a spatial filter in the Fourier plane of the imaging lens for masking off the diffraction pattern produced by the background on the semiconductor wafer from both illuminating beams of light.

3. (Twice Amended) A method for detecting the presence of contaminant particles on a semiconductor wafer having repetitive patterns, said apparatus comprising:

[a.] (a) illuminating a portion of the semiconductor wafer with first and second beams of light,

[b.] (b) said first beam of light striking the semiconductor wafer at a first approach angle which is angularly adjustable and a first angle of incidence which is angularly adjustable,

[c.] (c) said second beam of light striking the semiconductor wafer at a second approach angle which is angularly adjustable and a second angle of incidence which is angularly adjustable,

[d.] (d) said first approach angle and said first angle of incidence being adjustable independent of said second approach angle and said second angle of incidence, respectively,

[e.] (e) adjusting said first and second approach angles to minimize background scatter,

[f.] (f) positioning an imaging detector above the semiconductor wafer for detecting at least some of the light scattered from the area illuminated but not specularly reflected light,

[g.] (g) providing an imaging lens for imaging said area illuminated on said imaging detector, said imaging lens having a Fourier plane,

[h.] (h) providing a spatial filter in the Fourier plane of the imaging lens for masking off the diffraction pattern produced by the background on the semiconductor wafer from a first one of the two beams of light, and

[i.] (i) adjusting said angle of incidence of the other beam of light so that the diffraction pattern formed by the other beam of light in the Fourier plane overlaps the diffraction pattern formed by the first beam of light.

4. (Twice Amended) An apparatus for detecting the presence of contaminant particles on a semiconductor wafer having repetitive patterns, said apparatus comprising:

(a)[.] a light source adapted to produce a first beam of light and a second beam of light, said first beam of light being disposed to illuminate a region on the semiconductor wafer at a first approach angle which is angularly adjustable and a first angle of incidence which is angularly adjustable, said second beam of light being

disposed to illuminate another region on the semiconductor wafer at a second approach angle which is angularly adjustable and a second angle of incidence which is angularly adjustable, the first approach angle and the first angle of incidence of said first beam of light being adjustable independent of the second approach angle and the second angle of incidence of said second beam of light,

(b)[.] an imaging detector disposed to detect light scattered from the regions illuminated but not light specularly reflected from the area illuminated,

(c)[.] an imaging lens for imaging the regions illuminated on said imaging detector, said imaging lens having a Fourier plane, and

(d)[.] a spatial filter disposed in the Fourier plane of said imaging lens for masking off the diffraction pattern produced by the background of the semiconductor wafer from both beams of light.

5. (Amended) An apparatus for detecting the presence of contaminant particles on a semiconductor wafer having repetitive patterns, said apparatus comprising:

(a)[.] a first tower producing a first beam of light, the first beam of light illuminating a first region on the semiconductor wafer at a first approach angle and at a first angle of incidence, said first tower being angularly movable so as to change the first approach angle,

(b)[.] a second tower producing a second beam of light, the second beam of light illuminating a second region on the semiconductor wafer as the first beam of light, the second beam of light illuminating the semiconductor wafer at a second approach angle and at a second angle of incidence, said second tower being angularly movable so as to change the second approach angle, said second tower being angularly movable

independent of said first tower,

(c)[.] an imaging detector disposed to detect light scattered from the regions illuminated but not light specularly reflected from the area illuminated,

(d)[.] an imaging lens for imaging the area illuminated on said imaging detector, said imaging lens having a Fourier plane, and

(e)[.] a spatial filter disposed in the Fourier plane of said imaging lens for masking off the diffraction pattern produced by the background of the semiconductor wafer from both beams of light.

11. (Amended) An apparatus for detecting the presence of contaminant particles on a surface of a semiconductor wafer having repetitive patterns, said apparatus comprising:

[a.] (a) a holder for holding said semiconductor wafer,

[b.] (b) a light source adapted to produce a first [bream] beam of light and a second beam of light, said first beam of light being disposed relative to the semiconductor wafer to illuminate a first stripe shaped region on the semiconductor wafer at a first approach angle which is angularly adjustable, said second beam of light being disposed to illuminate a second stripe shaped region on the semiconductor wafer at a second approach angle, which is angularly adjustable, said second stripe shaped region intersecting said first stripe shaped region,

[c.] (c) a CCD camera, said CCD camera being operational in a time delayed integration (TDI) mode, said CCD camera having a sensor,

[d.] (d) an imaging lens disposed above the two stripe shaped regions for imaging onto said CCD camera at least a portion at an area on the surface containing

at least a portion of the two stripe shaped regions using scattered light as the semiconductor wafer is moving, the imaging lens having a Fourier plane,

[e.] (e) a filter disposed in the Fourier plane of said imaging lens for masking off the diffraction pattern produced by the background of the semiconductor wafer [form] from both beams of light, and

[f.] (f) means for moving said holder continuously.

15. (Amended) A method for detecting the presence of contaminant particles on a semiconductor wafer having repetitive patterns, as said semiconductor wafer is moving, said method comprising:

(a)[.] illuminating a pair of intersecting stripe shaped regions on the semiconductor wafer using first and second beams of light,

(b)[.] said first beam of light striking the semiconductor wafer at a first approach angle,

(c)[.] said second beam of light striking the semiconductor wafer at a second approach angle,

(d)[.] collecting at least some of the light scattered from the two regions illuminated but not specularly reflected light as said semiconductor wafer is moving,

(e)[.] forming an image of the area illuminated using scattered light and a CCD camera operational in a time delayed integration (TDI) mode, and

(f)[.] masking off from the image formed the diffraction pattern produced by the lens from the background on the semiconductor wafer.

18. (Twice Amended) An apparatus for detecting the presence of contaminant particles on a semiconductor wafer having repetitive patterns, said apparatus

comprising:

[a.] (a) a holder for holding said semiconductor wafer, movable along two mutually perpendicular axes,

[b.] (b)a pair of linear motors for moving said holder translationally along two mutually perpendicular axes,

[c.] (c) a light source for illuminating a stripe shaped region on the semiconductor wafer,

[d.] (d) a CCD camera having a square array sensor and constructed to operate in a time delayed integration (TDI) mode disposed to detect light scattered from the stripe illuminated but not light specularly reflected from the area illuminated,

[e.] (e) an imaging lens for imaging continuously the area illuminated by the stripe shaped region on said imaging detector s said holder is moved, said imaging lens having a Fourier plane, and

[f.] (f) a filter disposed in the Fourier plane of said imaging lens for masking off the diffraction pattern produced by the background of the semiconductor wafer from the beam of light.

19. (Twice Amended) A method for detecting the presence of contaminant particles on a semiconductor wafer having repetitive patterns, said method comprising:

[a.] (a) illuminating a pair of intersecting stripe shaped regions on the semiconductor wafer, and

[b.] (b) detecting at least some of the light scattered from the area illuminated but not specularly reflected light as said semiconductor wafer is moving using a lens and

CCD camera having a square array sensor and operational in a time delayed integration model.